BROOKHAVEN NATIONAL LABORATORY NATIONAL SYNCHROTRON LIGHT SOURCE		Number: LS-SDL-0006 Effective: 10/22/2004	Revision: B Page 1 of 4
Subject: **SDL Radiation Interlock**			
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Review Log

Introduction:

The Source Development Lab (SDL) formerly known as the ELF requires an interlock to protect personnel from the radiation levels present inside the linac area and gun enclosure during operation. The radiation levels present inside the linac area and gun enclosure during operation qualify the area as a Radiation Area. An interlock system has been designed to meet the requirements within BNL Rad Con Manual and ESH Standard 1.5.3 Interlock Safety for Protection of Personnel.

Advice and concurrence with the design was provided by the NSLS Interlock Working Group (IWG), and an independent committee of NSLS staff members appointed for this purpose. The departmental review is recorded in the Q.A. documentation and maintained by the NSLS. The system is installed and is become part of the inventory of personnel protection systems at the NSLS, with responsibility for testing and configuration control resting with the NSLS Safety Officer and his designees. Periodic testing is performed every six calendar months or after any maintenance is performed on the system. Tests are conducted according to written test procedure maintained by the NSLS QA Manager.

System Description

The interlock is a simplified version of the standard NSLS hutch interlock, using perimeter control, search sequence, emergency stop, and warning provisions of that design. Protection is provided by turning off the linac modulators and gun. The system has no interlocked beam stops. There are two independent interlock chains A and B, comprised of switches on doors, contact modules on stop buttons, Kirk key switches and linac shutdown devices. The two chains have no electrical connections that are common. The A chain includes the search sequence, warning circuits, Kirk key release unit, check station latches, emergency stop switches, search time out and warning intervals, for the gun enclosure and the linac area. Chain A will act through the individual user interlock provided on each high voltage power supply in the modulators. The B chain includes door switches, Kirk key switches and emergency stop switches. Chain B will operate a dedicated contactor installed in the primary power path to each modulator high voltage power supply. These contactors were installed by NSLS personnel. A lockable switch will provide a means of locking out the linac security system to prevent unauthorized operation of the system and to perform maintenance.

The two entrance doors to the linac area and the gun enclosure doors are secured with Kirk locks. When the linac area is secured, the keys are captured in a key tree and the transfer key captured in the area solenoid release unit (SRU). Only when the interlock system is brought to the ground state will the keys be

released and allow access to the linac and gun enclosure areas. The keys can only be released from the door locks when the doors have been closed.
The gun enclosure has a separate search and interlock logic that allows access to the linac area while maintaining gun security. The loss of either linac area security or gun enclosure security will stop operation of the modulators through their respective chains. The top of the linac area is open; therefore active warning signs are installed and spaced appropriately around the perimeter of the linac area, warning that an active radiation area exists at the top of the shielding wall. The warning signs illuminate when the linac area is secured. Flashing red beacons located inside the linac area at the top of the shielding wall provide the same warning as the signs. The beacons are placed such that they are only visible from the top of the wall and from inside the linac area. This is done so that the flashing of beacons do not become commonplace to personnel working in the area but at the same time provide warning to personnel working at the top of the shield wall or accidentally inside the linac area when it is interlocked.

Operation

The gun enclosure must be searched first to ensure that there are no personnel left inside when the radiation interlock is activated. The gun enclosure may have personnel inside during the operation of the laser system for alignment purposes however personnel are not permitted inside the gun enclosure or linac area when the radiation interlock is activated. There is no mechanism for a person acting alone to secure the radiation interlock for the gun enclosure and remain inside without bypassing one or more of the system components.
The gun enclosure is searched for personnel and then the CS-1(Check Station 1) button is pressed inside the gun enclosure, the red strobe light will begin to flash to warn that the area is being readied for the introduction of radiation. The person securing then exit's, closing the gun door and pressing the CS-E located on the outside of the gun enclosure. At that time the warbling warning siren sounds inside the gun enclosure for 30 seconds and the 'Interlocked ' sign above the gun door illuminates. The strobe inside the enclosure remains flashing as long as the gun is interlocked. At the end of the warning time the gun enclosure is in a secured state and the linac search can begin.
The search of the linac area requires one person. The initial conditions for a search are that all emergency stops are reset, the labyrinth door is closed, the Kirk key inserted in the transfer unit and the gun enclosure is secured. The person searching the linac enters the linac area using the East door, closes the door and presses the Door Guard button. With the door guard activated, anyone entering through either door will trip the search and require another search to be performed. The door guard prevents a person from entering the linac area unnoticed while the other person is performing a search. It in no way bypasses any function. After the door guard button is pressed the person securing proceeds to the West end of the linac, on the way they will observe through the mirrors above the linac sections that there is no one behind the linac sections. When at the end of the linac area they will cross under the beam pipe and proceed back down towards the gun on the north side of the linac to CS-1. After assuring no persons are encountered the searcher presses CS-1. Then the

searcher proceeds to CS-2 located at the west end of the linac enclosure and presses the button. Along the way the searcher will announce that the area is being secured and will only press a check station if no one is encountered.
The searcher then proceeds to CS-3 located near the Light Curtian and presses the button. The searcher will then go to the labyrinth door, search the labyrinth area and press CS-4, then proceed to the main entrance door. Upon reaching the main door the person securing will press the Door Guard button and exit. After closing the door, the Kirk key is removed from the door and placed in the transfer unit, the transfer key is rotated, removed and placed in the SRU and rotated, the CS-E button is then pressed. The warbling siren will sound for 30 seconds, the 'Interlocked' signs, beacons, interior strobes and the warning signs illuminate. At the end if the warning period the interior strobes go out and the modulators are ready for operation.

When the area is no longer needed to be interlocked and access is required the interlock must be brought to the ground state before the keys can be removed from the SRU. To bring the interlock to the ground state the 'Interlock Off' button must be pressed; it is located next to the interlock logic box. The interlock off function brings the interlock system to the unsecured state and disables both A and B chains. It does not disable or bypass the interlock. The interlock off function does not bring the gun enclosure security to the ground state.
The gun enclosure security can be broken by opening the gun doors. In the event of the interlock being violated either by a door being opened or a key being turned there will be a 5 second warning sound. When using the interlock off function the warning does not sound.
Emergency stop buttons are placed at locations in the linac area, the gun enclosure, and at specific locations outside of the linac. Pressing these buttons will disable the A and B chains. This will require the operator to reset the emergency stop and the Safety Officer Reset (SOR) function with a controlled key.
The doors to the linac area and the gun enclosure are secured with Kirk locks, in the event of a personnel being left in these areas unintentionally, egress is possible by pulling the release ring, that detaches the Kirk lock and allows the door to be opened.
The system may be locked out for maintenance and administrative purposes by rotating the lockout switch located on the logic box. The lockout switch has provisions for the application of a lock and red tag. When the lockout switch is rotated back to the operate position the SPA function will require a reset by the operator before normal operation can begin.